

XXIV. *Account of a new Electrometer.* By Mr. Abraham Brook; *communicated by Sir Joseph Banks, Bart. P. R. S.*

Read May 30, 1782.

AAAAN, fig. 1. represents the electrometer in full size and proportion, standing on a table, or the like. The foot B is a square piece of board,  $9\frac{1}{4}$  inches each way, resting on three pins C, C, c, seen at the under side of the foot. C, C, with the broad heads, are screws to set the instrument upright withal. D is a solid piece of glass, which supports and insulates the instrument from the place on which it stands. The arms G<sub>1</sub> and g, with the ball F, turn round on the wire H (which is solid brass, as may be also the arm g), and, when in use, are put near at a right angle with G<sub>2</sub> and H, being turned to the off side so as to be as much as possible out of each other's atmospheres or the atmosphere of a jar, battery, prime conductor, &c. The arms G<sub>1</sub> and G<sub>2</sub> are hollow tubes of copper, not so heavy as wires. The balls I<sub>1</sub>, I<sub>2</sub>, are made of copper, and hollow, so as to be as light as possible. K represents a kind of face or dial plate to the instrument with its index, which is carried once round by the motion of the arm G<sub>2</sub> with its ball I<sub>2</sub> moving through a quarter, or 90 degrees, of a circle; this motion is given to it by the repulsive power of the charge, &c. of electricity between the two balls I<sub>2</sub> and L. The ends of the index from its center are of different lengths. The longest end reaches to a graduated circle, divided into 90 equal parts, answering

answering to the  $90^\circ$ , which the arm  $G_2$  moves through. The shortest end reaches to a smaller circle, divided into 60 equal parts, answering to 60 grs. weight, or 60 divisions, on the arm  $G_1$ , with its sliding weight  $m$ , each of which is equal to one grain, and the whole face is covered with a watch glass, to prevent the electricity from flying off at the points.

The top of the glass-supporter, or insulator  $D$ , is cemented into a brass cap  $M$ . This cap enters the ball  $L$  at bottom, and screws into the upper part of the ball  $L$  at  $a$ . The top part of this cap  $M$  is tapered off to a cone about an inch and a half long or high. The lower end of the wire  $H$  has a hole made conically into it, so as to receive the upper part, or conical end, of the cap  $M$ , which permits all the upper part of the electrometer to turn round any way that may be necessary. The kind of ferrel  $O$ , with its base, is perforated for the lower end of the wire  $H$  to go through. The bent arm  $b$ , which supports the cup  $N$ , is screwed into the base of the ferrel  $O$ , and turns freely round upon the wire  $H$ . The cup  $N$  is to receive the ball  $P$  of the arm, fig. 9. This arm shortens or lengthens, as may be wanted, by a wire sliding into a tube. The end of the wire is slit, forming a spring in the tube to be steady. In this arm, fig. 9. is a kind of rule joint at  $d$ , that the arm may give way easily if wanted. The semi-circular end of the arm is a spring, and slips on to a ball from the prime-conductor, or the conductor itself (if they fit), jar, or battery. The ends of it are flat and broad, as represented in the drawing in miniature, of the electrometer at fig. 2. in the other drawing.

Fig. 2. to 11. shews the internal structure of the electrometer.

Fig. 12. shews the part at  $z$  that screws into the ball  $F$ , to support the arm  $g$  with its ball  $r$ . This piece, which is made

hollow on the side next the wire H, so as to fit, and is screwed in, so as to press against H, serves as a spring to keep the ball F steady, which slides up and down, as well as turns round, on H.

In order to make the divisions of G<sub>1</sub>, fig. 1. exactly a grain each, first slide the weight *m* towards the ball F, fig. 1. till it is an exact counter-balance to the weight in F. At one end of the weight *m* let the divisions begin; then suspend any tolerable pair of scales, so that the bottom of one of them may rest on the top of the ball *r*; then lay the ball I<sub>1</sub> into the scale, and slide the weight *m* near to I<sub>1</sub>, and put as many grains into the other scale as will just raise the ball I<sub>1</sub> in the scale; then mark the arm G<sub>1</sub> at the same end of the weight *m*, and divide the space between the two marks into as many parts as there are grains in the scale, which may be divided and sub-divided into halves and quarters.

The arm G<sub>2</sub> being repelled shews when the charge is increasing, &c.; and I<sub>1</sub> tells what such a repulsive power is between two balls of the size of these in grains, according to the number the weight *m* rests at when lifted up by the repulsive power of a charge. The longest end of the index K shews how many degrees of a circle G<sub>2</sub> is repelled; and, by many trials, according to the number of grains, the arm G<sub>1</sub> shews, when it is lifted up, and the weight *m* put at different places, such respective numbers of grains may be marked on the least graduated circle on the dial plate where the shortest end of the index points; so that when all the grains are thus marked on the dial plate, thus ascertained by the arm G<sub>1</sub>, all these parts of the instrument, that is, the ball F with the arms G<sub>1</sub> and *g* may be taken off, and the instrument is then graduated to be used without them; but I do not know how the grains can be so  
exactly

exactly marked and ascertained as by these parts being on the instrument: nor do I mean to confine the number of grains or divisions on  $G_1$ ; but, I think, my experience seems to tell me, that no glass to be *charged*, as we call it, with electricity, will bear a greater charge than that whose repulsive force, between two balls of this size, equals 60 grains weight, before it will be perforated or struck through. Nay, I have not found many instances where it would stand 50 grains; and, I think, it is very hazardous to go more than 45 grains.

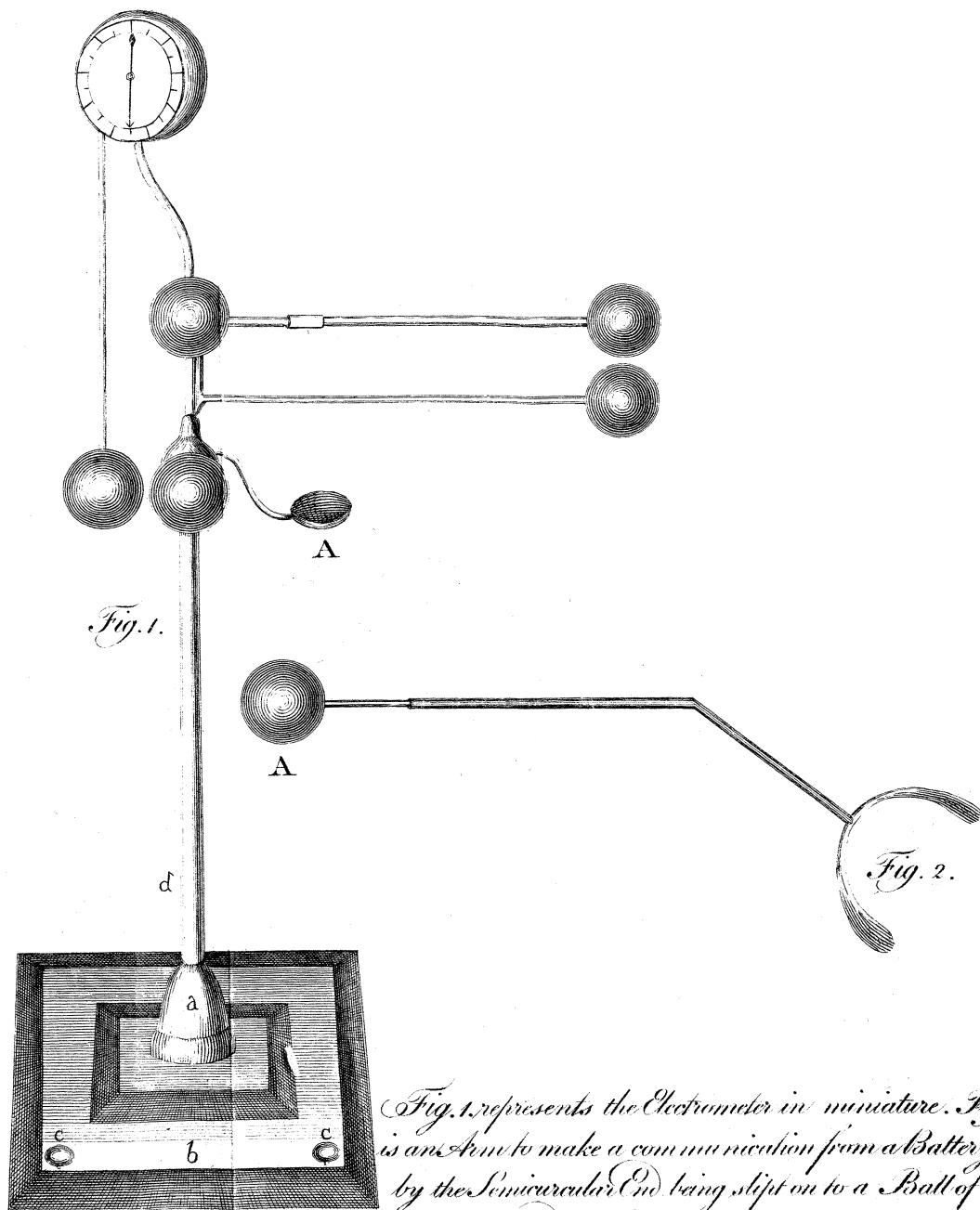
Thus, by knowing the quantity of coated surface, and the diameter of the balls, as  $I_1$  and  $r$ , I would say, so much or so much coated surface charged to so many or so many grains repulsion between two balls of such or such a size would melt a wire of this or that size, or do such a thing, kill such an animal, &c.; and if balls, wires, or arms of this size, are found too small, larger may be made on the same plan.

In respect to the advantages of this electrometer above *those now in use*, I do not, perhaps, know them all; and lest my partiality may prejudice me in behalf of my own contrivance, would rather leave them to the judgement of others; my opinion however is, that all that I have seen or heard of are such as speak no intelligible language, and that this speaks so as to be understood universally; for, unless the repulsive power of the charge of different glasses be very different, this electrometer, or any other electrometer, made after this manner, must, I should think, speak very nearly the same language, it being known how much coated surface there is, and the size of the balls; but if the size of the balls be not the same, the language the instrument speaks will be very different. Although other Electrometers shewed a

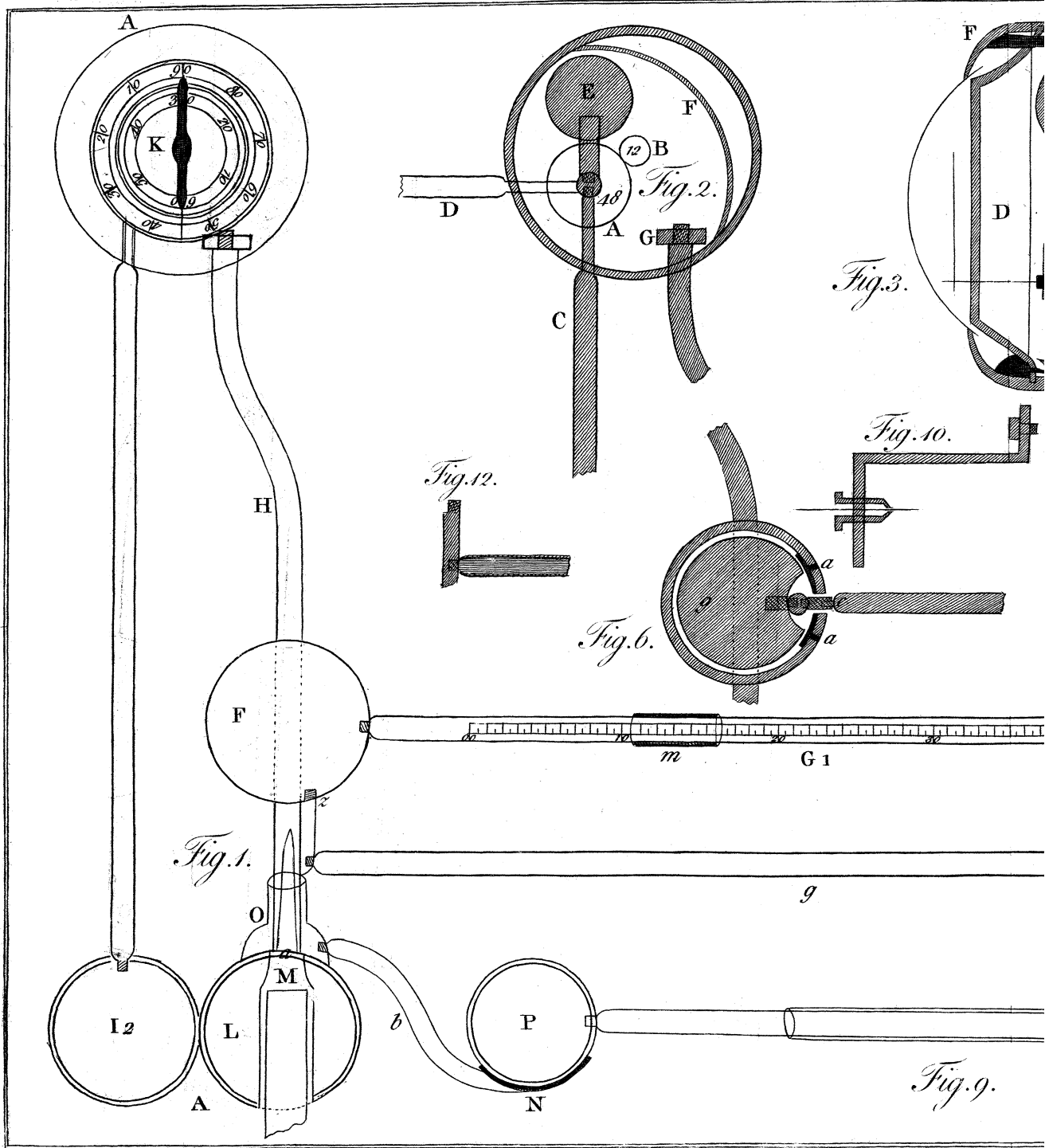
greater or lesser charge or power, by an arm being repelled to a greater or lesser distance, or by striking differently at different distances, yet the power of the charge was not in any manner ascertained; we could say, that the arm or index was repelled to such or such a number of degrees of a circle, or that it struck to such or such a distance; but the repulsive power of a charge to repel the index so much, or so many degrees of a circle, or the strength of the charge to strike to such a distance was not (that I know of) in any manner intelligibly ascertained. This shews it by the weight that the repulsive power has to lift up in grains, &c.; which weight is to be proved by any tolerable pair of scales and weights; and I do not know any other method that has been yet tried to shew the different strength of charges so good as that of repulsion.

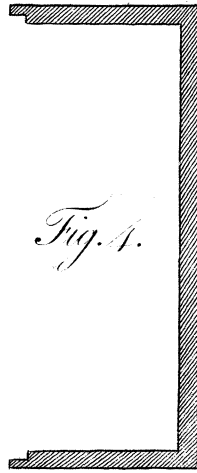
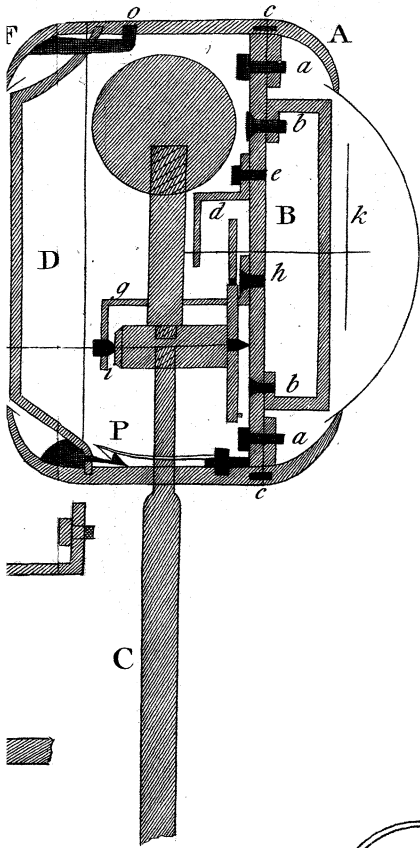
All the necessary parts of the instrument being made of metal and glass that is pretty stout, I think, the electricity is less liable to escape than by wood, &c. I have tried reeds on account of their being light, and covered them with tin-foil, or gilded them to make them good conductors; but so frequently found inconveniencies from them by points rising up, the celerity of moving, and the different weight of them at different times owing to moisture, change of the weather, and the like, that I have laid them all aside, and find my present instrument as free from these inconveniencies as I could expect; nor is it liable to be out of order, if proper care is taken of it.



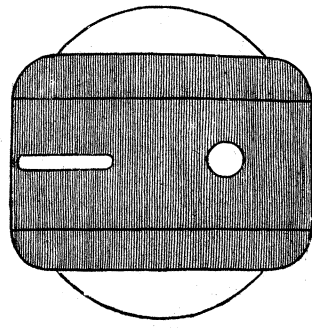


*Fig. 1. represents the Electrometer in miniature. Fig. 2. is an Arm to make a communication from a Battery, &c. by the Semicircular End being slipt on to a Ball of the Battery &c. and the Ball A being laid into the Cup A. Fig. 1.*

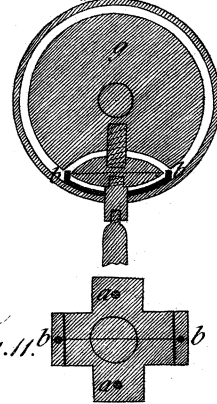




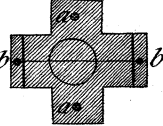
*Fig. 5.*



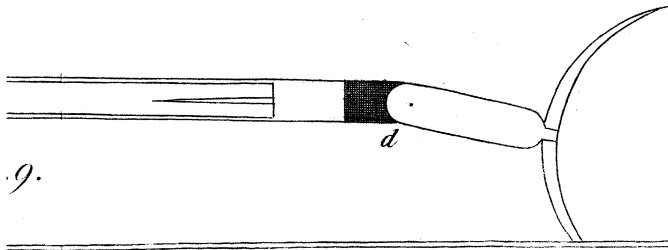
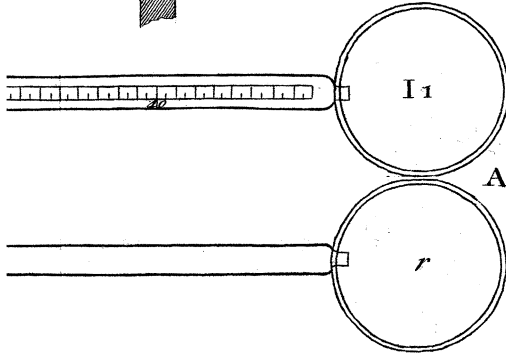
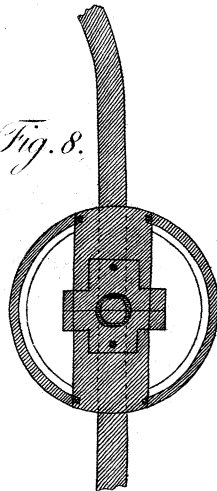
*Fig. 7.*



*Fig. 11.*



*Fig. 8.*



*9.*



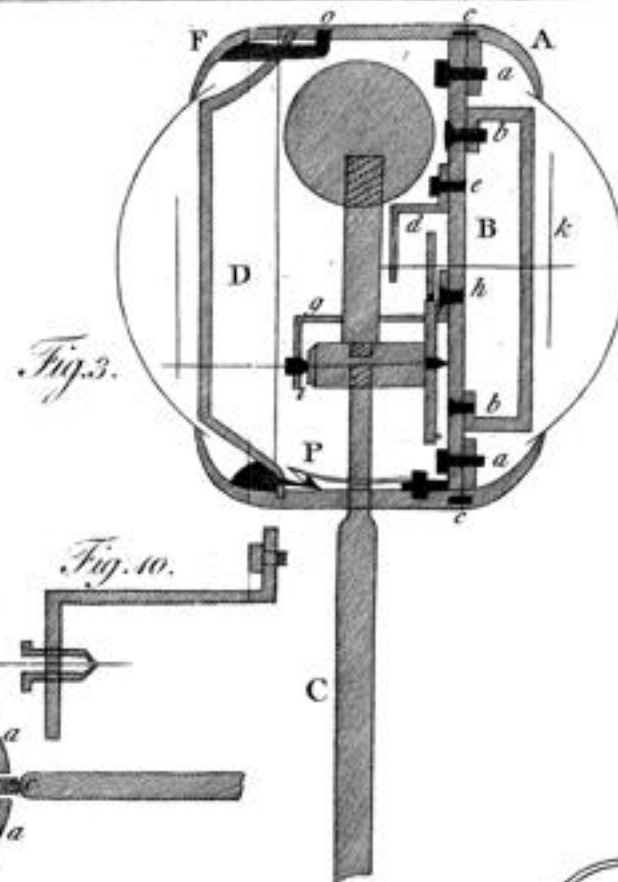
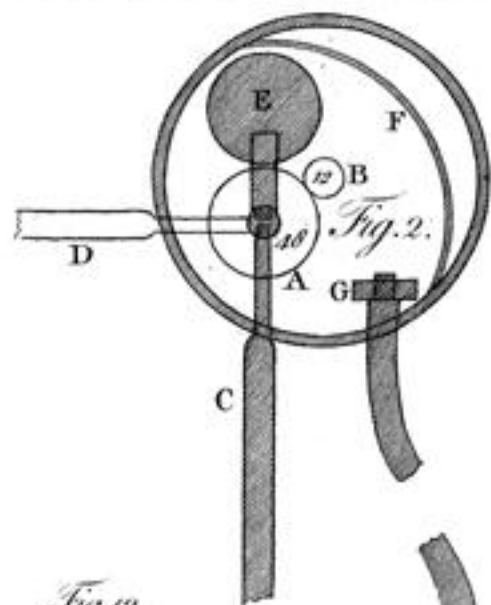
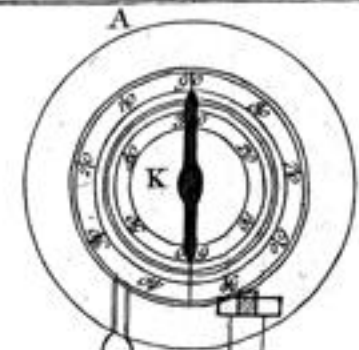


Fig. 5.

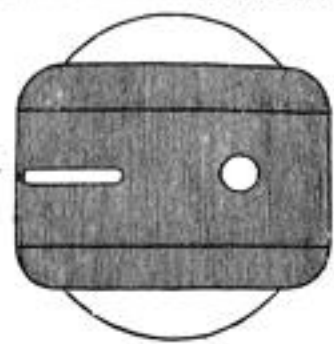


Fig. 7.



Fig. 8.

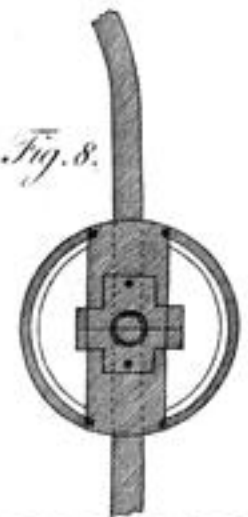


Fig. 12.



Fig. 10.

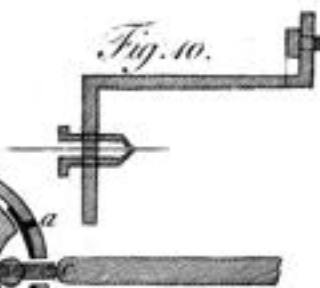


Fig. 6.

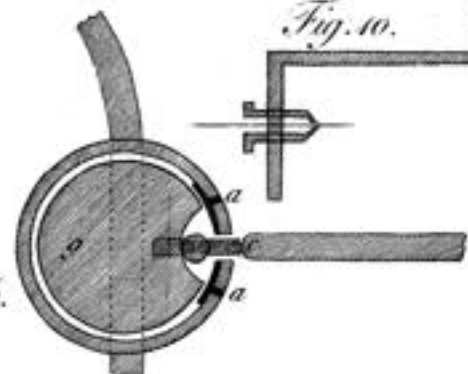


Fig. 1.

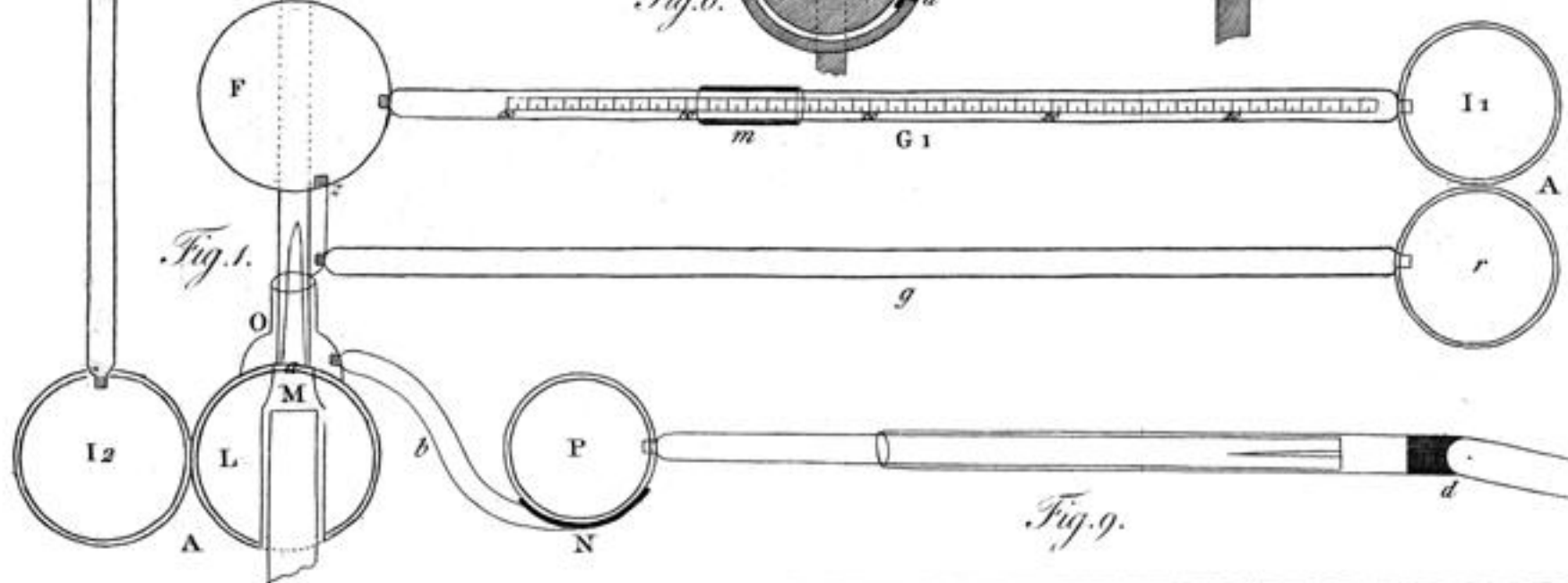


Fig. 9.